

supplied a sense-organ of the supraorbital canal and sent a few twigs to the surrounding skin.

This somewhat complicated description when compared with the figure will, I trust, make it clear that these two supraorbital sense-organs in *Chimæra* do not, as was supposed, present an anomaly in their innervation, but receive their nerves in all likelihood from the superficialis as do the other organs of that canal, and in their mode of innervation show a close similarity to those that lie in front of them; for in both cases the actual nerve-trunk from which the filaments for the individual sense-organs arise is of a compound nature formed by an intimate blending of the superficialis VII with the profundus V, differing only in the fact that in the case of these two sense-organs the union occurs between the smaller branches of the nerves, while in that of the organs in front it involves their main trunks. In both cases the fusion is so complete, that it is impossible by simple dissection to say definitely that the fibres derived from the superficialis terminate in the lateral-line sense-organs, while those of the profundus are distributed to the skin; but the probabilities that such is the case are so great as to almost amount to certainty.

3. Contributions to the Knowledge of the Structure and Systematic Arrangement of Earthworms. By FRANK E. BEDDARD, M.A., F.R.S.

[Received January 31, 1901.]

(Text-figures 50-58.)

1. On *Polytoreutus gregorianus*.

This species was very briefly defined by me five years ago in my Monograph of the Oligochæta¹. Since then the publication of descriptions and illustrations of various new species of the genus has decided me to attempt an addition to our knowledge of this remarkable genus by a fuller account of the form which I named after Prof. Gregory of Melbourne, and which was collected by him in Africa during his expedition of 1894.

The worm measures 230 mm. in length by a diameter of 9 mm. The number of segments are between four and five hundred². As might be supposed from their large numbers, the segments are very short; this is the case with all those lying behind the clitellum; those forming the clitellum and those lying in front of it are stout segments as in other earthworms.

The setæ, as in other species of *Polytoreutus*, are in couples, of which the two lateral are more closely approximated to each other than the two ventral. The disproportion of the spaces separating the two lateral setæ from each other and the two ventral setæ is

¹ Oxford, Clarendon Press, 1895, p. 612.

² These measurements differ slightly from those which I originally gave.

greater in the present species than it is in some others. Thus in *P. arningi* Dr. Michaelsen observes¹: "Die ventralen Paare sind sehr weit, ungefähr $\frac{2}{3}$ so weit wie die ventral mediane und die lateralen Borstendistanzen. Die dorsalen Paare sind eng, nicht ganz halb so weit wie die ventralen." In *Polytoreutus gregorianus*

Text-fig. 50.

*Polytoreutus gregorianus*. Head-end, $\times 2$.

♂, male pore; ♀, female pore; P, papilla.

the interval between the two setæ of a ventral pair measures 2 mm., and is pretty nearly exactly half of the median ventral

¹ "Neue und wenig bekannte afrikanische Terricolen," Jahrb. Hamb. wiss. Anst. xiv. 1897, p. 53 (of memoir).

space lying between the ventralmost seta of each side. The lateral setæ are so closely approximated that they are not more than $\frac{1}{3}$ of a millimetre from each other. The distance of the lateral pair from the outermost seta of the ventral pair is about equal to that of the ventral median space. The dorsal median space measures 11 mm. The total circumference of the worm is thus about 27 mm. At the tail end of the body the space between the setæ of the ventral pair retains its width until the very extremity when it is narrowed. This, however, is simply a matter of the diminished calibre of the body; there is no proportional decrease in the interval. I could find no dorsal pores, which structures appear to be absent in the family *Eudrilidae*.

The *nephridiopores* are very obvious and lie in front of the lateral setæ.

The *clitellum* occupies segments xiii.-xviii. and is completely developed all round the body.

Dotted over the segments, and often forming continuous lines with the setæ suggestive of a perichæatous condition, are the numerous integumental sense-organs, well known to occur in this genus.

In my Monograph of the Oligochæta the position of the external generative apertures is accidentally reversed. In *Polytoreutus gregorianus*, as in all the other species of the genus, the male pore lies in front of the spermathecal pore.

The *male pore* (see text-fig. 50, p. 188) is placed accurately between segments xvii./xviii. It is transversely oval, indeed slit-like, and lies at the summit of a protuberance which occupies the middle part of segments xvii. & xviii. between the ventralmost setæ. On the xviiith segment this protuberance appeared to bear two faintly marked papillæ, one on either side.

The *spermathecal pore* is on the sixth segment, quite in the middle of that segment; it is rather a larger orifice than the male pore.

I append for the purposes of comparison drawings (text-figs. 51, 52, p. 190) of the external characters of the two species *Polytoreutus kilindinensis* and *P. finni*. Of neither of these species have the external characters been at present figured¹, though their internal structure has been dealt with by myself². Figures of the external characters of the genus *Polytoreutus* are at present limited to a figure of *P. magilensis*³.

It will be noticed that while *P. kilindinensis* entirely agrees with *P. gregorianus* in the position of the male pore and of the spermathecal orifice, *P. finni* differs in that the male pore is very distinctly in the middle of the xviiith segment, and the spermathecal pore is situated on the boundary line of the xviiith and xixth.

It will be observed from the accompanying sketch (text-fig. 51)

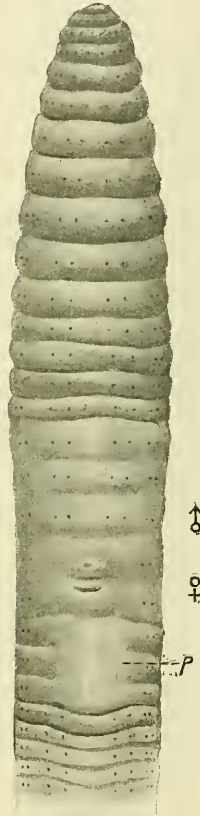
¹ Save for a quite rough sketch of *P. finni*.

² "Oligochæta of Tropical Eastern Africa," Quart. Journ. Micr. Sc. vol. xxxvi. p. 236.

³ "Some new Species &c. of Earthworms," *ibid.* vol. xxxiv.

of *P. kilindinensis*, that the area bearing the reproductive apertures is continued as a glandular swelling over the next four segments. The divisions between these segments, except that between the last two, *i. e.* xxii./xxiii., are obliterated over this area, which is seen on a lateral view of the body to protrude somewhat.

Text-fig. 51.



Text-fig. 52.

Text-fig. 51.—*Polytoreutus kilindinensis*. Head-end, $\times 3$.

♂, male pore; ♀, female pore; P, papilla.

Text-fig. 52.—*Polytoreutus finni*. Head-end, $\times 5$.

(Letters as in text-fig. 50.)

Polytoreutus gregorianus has a similar "Pubertätspolster," as Michaelsen has termed this structure. But in this species it is much more extensive. It presents, however, the same character of a swollen glandular eminence, which is seen on a lateral view

of the worm to protrude considerably beyond the general level of the body. This glandular eminence is of a stronger yellow colour than the surrounding body-wall, and is therefore additionally conspicuous. The outer setæ of the ventral couples are just not embraced by it. It occupies all of segments xix.–xxiv., and the intersegmental furrows are perfectly plain throughout. In *P. violaceus* I described a somewhat similar modified area of integument upon the middle ventral region of segments xxii. & xxiii.: it is interesting to note that Michaelsen has found that in that species the position of the Pubertätspolster may vary from xxiii. or xxiv. to xxxii. or xxxiii., nearly the same area therefore that is *continuously* occupied in the present species.

The *oviducal pores* are very conspicuous upon segment xiv. They lie behind the lateral pair of setæ. They are asymmetrical in my specimen; the left-hand pore is nearer to the middle line than the right-hand pore.

As in other species of *Polytoreutus*, though the details are not always available in extant descriptions, a number of the anterior *septa* are thickened. The last of these bounds the xith segment posteriorly; this and the four septa lying in front of it are thickened to a very considerable extent; in front of the first there are two or three septa which are less pronounced. There is a gradual falling off in thickness in the case of the septa lying behind that which bounds the eleventh segment; the first of them, like the rest, is thin and diaphanous. It is only the septa in the immediate neighbourhood of the gizzard, and which closely envelop it, that are much tied together by threads of muscle in the way that is prevalent among earthworms. The specially thick septa behind are not so interconnected.

The *nephridia* are regularly paired and furnished with a terminal sac.

It is perhaps not of importance as assisting in the definition of the species to note the double character of the dorsal vessel in certain segments. A continuously double dorsal vessel is, so far as I am aware, generally a specific and sometimes even (as in *Octochatus*) a generic character. But the fact that in *Pontoscolex* the dorsal vessel may be double for a segment or two, is perhaps not, as I was inclined to make it at one time, a specific character distinguishing *P. hawaiiensis*. However, in *Polytoreutus gregorianus*, as in *Polytoreutus kilindinensis*¹ (occasionally), the dorsal vessel is double in segments xii. & xiii. and again more anteriorly in segments viii. & ix.

The two halves were only separated for a short distance, again reuniting. The dorsal vessel is particularly stout and congested with blood in the three segments which immediately follow the last strong septum; and in these segments there are no hearts. The last of the hearts lie in segment xi., and they and the pair in front are the largest of the series.

¹ Beddard, Quart. Journ. Micr. Sc. vol. xxxvi (n. s.) p. 240.

The *alimentary canal* conforms to the type characteristic of this genus. The gizzard, which is distinctly stout, lies in the fifth segment. The *œsophagus* is rather a narrow tube up to the ninth segment, where it dilates, but still retains its comparatively thick walls and may therefore be still termed *œsophagus*. A segment or two later (I cannot unfortunately be precise) the thin-walled intestine begins. In the three segments ix., x., xi., there are—one on each—the usual three median and ventral calciferous pouches whose relations call for no special comment; they are apparently common to all the species of this genus. The calciferous glands of the thirteenth segment are large and partly encircle the gut. They are imperfectly divided into a dorsal and a more ventrally situated half. From each arises a longish and slender duct which converges towards, and finally unites with the other before its opening into the *œsophagus*. The two orifices are laterally situated upon the *œsophagus*.

Organs of Reproduction.—As my specimen was rather too large, and not sufficiently well preserved to be conveniently studied by the method of transverse sections, I am compelled to limit myself in describing the structure of the organs of reproduction to such points as could be ascertained with the help of a lens.

As in other species of the genus, the *sperm-duct* dilates into a large oval chamber immediately after leaving the funnel. This dilatation lies in the ninth segment and is attached to its thick posterior wall.

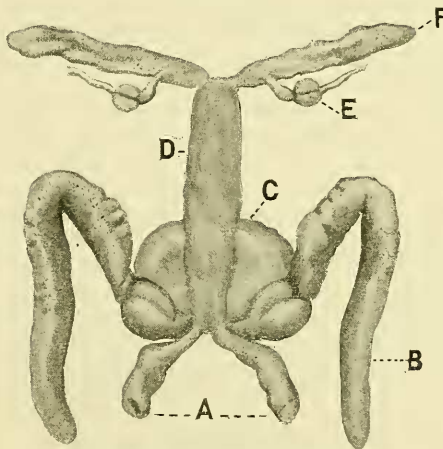
In contact with and to the inside of each of these dilatations of the *sperm-duct* is a thin-walled sac. The two sacs are not fused or even in contact in the middle line, but they represent, I take it, the *sperm-reservoirs* of other earthworms. They appear to be continuous with the single pair of *sperm-sacs* through a deficiency in the thick septum, which also allows the *œsophagus* to pass into the next segment.

The *sperm-sacs*, as is the case with the other species of this genus, are of considerable length and are separable very distinctly into two regions. The total length of each of the two *sperm-sacs*, in the contracted condition of the worm, is about 30 mm. from the septum to which they are affixed anteriorly to the point upon the intestine where they terminate posteriorly. The posterior more swollen region of each of the two sacs is longer than the almost thread-like anterior portion; it measured 18 mm. The demarcation between the two regions is extremely abrupt, though the posterior part of the *sperm-sac* has not at that point acquired its full dimensions; it becomes gradually wider later until it again gradually narrows towards its posterior termination. The dilated region of the *sperm-sacs* occupies some thirteen segments, where they for the most part conceal the underlying dorsal vessel. Anteriorly and posteriorly, but only for one or two segments at each end, the *sperm-sacs* are not constricted by and do not bulge out between the intersegmental septa. In the middle of the course of the sacs there are these constrictions, which in the preserved and therefore

contracted state of the worm render it a little difficult to map this portion of the sperm-sacs accurately. The reason is that the greatly bulged divisions of the sperm-sacs do not lie so plainly and simply side by side as they do both anteriorly and posteriorly; they are somewhat intertwined by the exigencies of space in relation to their own increasing bulk, but do not, at least so far as I have been able to ascertain, intercommunicate at these points. In any case there is no doubt that at the very end of their course the two sperm-sacs are perfectly continuous, there being no externally visible break where one passes into the other; the two sacs thus end posteriorly in a somewhat horseshoe-shaped loop.

The *spermiducal glands* measure about 20 mm. in length; but they do not occupy a corresponding length of the body since each is bent once and sharply upon itself; this bend does not mark off the spermiducal gland into two regions, though each gland can be so divided. When the gland emerges from the terminal bursa

Text-fig. 55



Polytoreutus gregorianus. Genitalia, $\times 2$.

A, posterior lateral diverticula of spermathecal sac; F, anterior do.; E, receptaculum ovarium; D, median part of spermathecal sac; C, terminal bursa copulatrix, into which open B spermiducal glands.

copulatrix, through which it communicates with the exterior, it is at first narrow; it then gradually widens and forms an elongated heart-shaped tube, from the middle of the end of which arises the distal part of the spermiducal gland; the relations of the latter to the former part are very much those of a small intestine opening into a large intestine which is furnished at the junction of the two with two short blunt cæca. The point of junction of the two

parts of the spermiducal gland is rendered stronger by some external strands of muscle, which run across the line of junction and tie both parts to each other. These are shown in the accompanying drawing (text-fig. 53, p. 193). These strands of muscle, which are accompanied by blood-vessels, can be seen to spring fan-shaped to be detached from the walls of the spermiducal gland posteriorly. Their general appearance is not unlike that of the muscles which accompany the penial setæ in those earthworms which possess them. In the present genus such setæ do not occur, and it would be interesting to know whether their muscles have remained and have been utilized for the extra strengthening of the muscular spermiducal glands. The posterior region of the glands is slightly and irregularly sacculated; its walls are thick and chiefly glandular. The single sperm-duct crosses over the terminal heart-shaped portion of the spermiducal gland, and is at once lost in the wall of the narrow distal portion. The two spermiducal glands open posteriorly into the nearly circular terminal bursa. The latter is of course overlain by the spermathecal sac; its walls are very thick and muscular.

Spermathecal sac.—The species of the genus *Polytoreutus* are mainly to be distinguished from each other by the form of the very variable spermathecal sac. The present species, as is the case with all the others, can be defined by this structural feature alone. The sac extends as usual from just behind the last thickened septum to its orifice on to the exterior just behind the bursa copulatrix. It dips down sharply behind the last-mentioned structure. The sac therefore occupies rather more than 7 segments; it is some 9 mm. in length. The median spermathecal sac lies of course below the nerve-cord; it is entirely single throughout its course and is not divided into right and left nearly independent halves as in *P. magilensis*. The general appearance of the spermathecal sac will be quite obvious from the accompanying drawing (text-fig. 53, p. 193). As is the case with other species of this genus, the median sac is furnished with lateral diverticula.

The anterior end of the sac is provided with two long diverticula of cylindrical form, each one of which is, when fully extended, quite as long as the unpaired median sac. They touch each other above the intestine, but they are not fused at that point. The posterior pair of diverticula arise from the median sac just before its opening on to the exterior. They are distinctly shorter than the anterior pair of diverticula, but more swollen. The drawing also illustrates the relations of the oviduct, egg-sac, and egg-tube to the spermathecal sac. It will be noticed that the latter opens into the neck of the anterior diverticulum, close to its junction with the median unpaired spermathecal sac. The oviduct is long and but slightly curved. The chamber into which the oviduct opens ("Eitrichterblase") is of about the same size as, and is situated exactly opposite to, the egg-sac (receptaculum ovarum).

The species may be thus defined:

***Polytoreutus gregorianus*¹.**

P. gregorianus F. E. Beddard, Monogr. Oligoch. 1895, p. 612.

Length 230 mm., breadth 9 mm.; number of segments about 450. Setæ very widely apart in ventral couples, closely approximated in lateral. ♂ pore xvii./xviii.; spermathecal pore on xix. A glandular eminence upon median ventral surface of segments xix.-xxxiv. Dorsal blood-vessel double in some of anterior segments. Sperm-sacs thread-like for anterior two-fifths, wide and sacculated after, and fused at posterior extremity. Spermiducal glands hardly sacculated, divisible into a shorter terminal part and a longer cylindrical distal region. Spermathecal sac median, unpaired, with two anterior and two posterior diverticula.

Hab. Giriamia, E. Africa.

2. *A Contribution to the Knowledge of the Earthworm genus Typhoeus.*

This genus of Earthworms was founded by me² some years since for the reception of a single specimen of an earthworm from India. Later³ my own description of a second species as well as the investigations of Bourne⁴, Rosa⁵, and Michaelsen⁶, fully established the validity of the genus, which the last naturalist would regard as the type of a separate subfamily. The name which I originally wrote, in conformity with the Greek, *Typhoeus*, was erroneously altered into *Typhæus*, and subsequently into *Typhæus*, both of which are clearly wrong. It should obviously be written as in the present communication.

This genus is Indian, Burmese, and Ceylonese in habitat. It is perhaps, as Michaelsen has pointed out, closely related to such an Acauthodrilid as *Octochaetus*. But its characteristics do not allow of its being merged into that or any other genus, as the additional observations which I have to offer here amply confirm. I shall commence with the description of two new species lately received by me, and conclude with a revision of the whole genus, which now contains seven distinct species.

***Typhoeus nicholsoni*, n. sp.**

Of this apparently new species of the genus, I have examined three fully mature individuals. These I have received through the

¹ Named after Prof. J. W. Gregory of Melbourne University.

² "Note on some Earthworms from India," Ann. Nat. Hist., Oct. 1883, p. 219.

³ "On the Structure of three new Species of Earthworms, &c.," Quart. Journ. Micr. Sci. vol. xxix. p. 111.

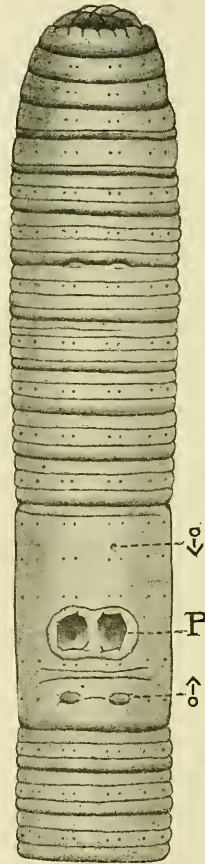
⁴ "On certain Earthworms from the Western Himalayas and Dehra Dun," J. A. S. B. lviii. p. 112.

⁵ "Viaggio di Leonardo Fea in Birmania e Regioni vicine: xxv. Moniligas-tridi, Geoscolicidi ed Eudrilidi," Ann. Mus. Civ. Genova, (2) ix. p. 23; and "Die exotischen Terricolen des k. k. naturh. Hofmuseums," Ann. k. k. Hofm. Wien, vi. p. 388.

⁶ "Die Terricolenfauna Ceylons," JB. Hamb. wiss. Anst. x. p. 90; and "Oligochæten von Inseln des Pacific, &c.," Zool. Jahrb., Abth. f. Syst., xii. p. 241.

kindness of Mr. Nicholson, of the Royal Gardens, Kew, who has sent me a large number of accidentally imported earthworms. These specimens are from Calcutta, and arrived in company with a large number of specimens of *Amyntas posthumus* and a few examples of other species of the same genus, and of a second species of *Typhoeus*.

Text-fig. 54.

*Typhoeus nicholsoni*. Head-end, $\times 3$.

♀, oviducal pore; ♂, male pores; P, papillae.

External characters.—The largest of the three specimens measures 145 mm. in length, with a diameter of 5 mm. These measurements apply to the worm after contraction by alcohol.

I counted 190 segments, which—with the exception of the last few—are annulated. The first three segments, moreover, show no

annulation. The fourth and fifth segments are each divided into two by a median furrow; the sixth is triannulate; the fact that the setæ occur in the middle ring of this segment, and on the anterior of the two which are biannulate, shows that it is the anterior annulus which is further subdivided. The three following segments have each four annuli, the setæ being implanted upon the second ring. Segments x., xi., xii. are again triannulate. After the clitellum the segments are more or less distinctly triannulate for a considerable distance back. The above description is drawn up from the specimen which I have regarded as the type; but the others show no differences save for incomplete additional furrows upon some of the segments.

The *prostomium* is broad, and does not at all impinge upon the first segment of the body. But a pair of furrows upon the first segment make with it a T-shaped piece.

There are naturally 8 setæ per segment, arranged in couples. The two couples of each side are close to each other and are quite ventral in position. The two setæ of the ventral couples are distinctly closer together than are those of the lateral couples. I found the lateral as well as the ventral setæ upon the clitellar segments; and setæ do not appear to be wanting upon the second segment of the body. It is not, however, easy to see them, since this segment, like the first, is marked by a number of short longitudinal furrows¹.

The *clitellum* of this species of *Typhoeus*, like that of others, occupies segments xiii.-xvii.

Dorsal pores are obvious after the clitellum, but seem to commence anteriorly to that part of the body.

As is the case with the majority of the already known species of the genus *Typhoeus*, *T. nicholsoni* possesses *genital papillæ*. There is a pair of these papillæ upon all of the three specimens in my possession, which are of a rather peculiar form. The area occupied by the papilla is, according to the state of contraction of the body, circular or more elliptical, the long axis of the ellipse being at right angles to the long axis of the body. A complete furrow separates the two papillæ from the surrounding integument, and they are separated from each other by a furrow. Their general appearance and relations can be gathered from an inspection of the accompanying drawing (text-fig. 54), which illustrates the ventral surface of this worm. The two papillæ occupy nearly the entire space between the ventral setæ of segments xv. and xvi. Laterally they extend for a very short way outside of the area thus defined. Each papilla has a central circular patch of different appearance from the peripheral part.

The *spermathecal pores* lie between segments vii./viii., and are very closely approximated ventrally; their orifices correspond in position to that of the innermost seta of the ventral couple.

The *male pores* are extremely conspicuous. They lie upon the

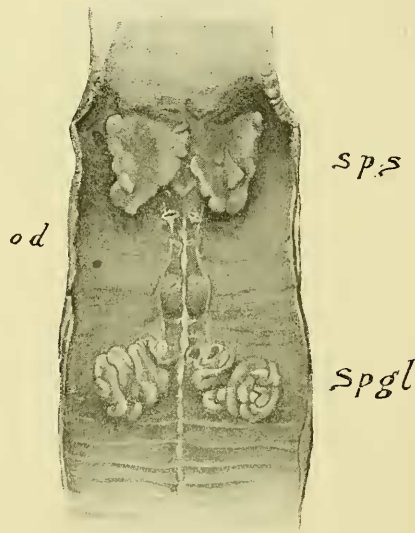
¹ This may possibly account for my failure to find them in *T. gammii*.

xviii segment and are close together like the spermathecal pores. The integument surrounding them is raised into a ridge. From each pore protrudes the everted end of the spermiducal glands.

The *oviducal pore*—for there is only one—offers a most remarkable case of asymmetry. In all three specimens there was but a single pore present, that of the left side. This pore is very conspicuous and lies just in front of the ventralmost seta of the fourteenth segment. There was no observable trace of a corresponding pore upon the opposite side of the body.

A dissection (shown in text-fig. 55) sketched without any instructions shows plainly that the oviduct of the right side is abbreviated and only just reaches the body-wall. Naturally, this

Text-fig. 55.



Typhoeus nicholsoni. Genitalia, $\times 3$.

sp.s., sperm-sacs; *od.*, oviducts; *sp.gl.*, spermiducal glands.

anomalous state of affairs was further investigated by section-cutting; I found that the two oviducts had funnels of quite the same size, but that the lumen of the right oviduct gradually diminished, and that the tube ended blindly just at the body-wall, which it does not perforate. The wide lumen of the left oviduct, on the other hand, is very obvious where it perforates the body-wall.

Alimentary canal.—The *gizzard* appears to occupy both the

seventh and the eighth segment, inasmuch as no recognizable septum divides those segments from each other.

The *oesophagus* extends back as far as the xvth segment, in which segment the intestine commences. The *calciferous glands*, of which there may be said to be a single pair in this as in other species of *Typhoeus*, do not present the appearance of discrete pouches opening into the gut; they form an oval reddish-coloured swelling situated in segment xii. The *intestine* has a typhlosole; but this is not apparent until segment xxx. (about). The characteristic *intestinal glands* of the genus are visible far back upon the intestine, commencing with segment lxxxiv. or thereabouts. They occupy in all five segments, and those of successive segments are separated by the septa. The dorsal vessel lies between the glands of the right and those of the left side.

Intersegmental septa.—A number of septa lying in front of and behind the gizzard are thickened. In front of the gizzard are two such septa; behind the gizzard are three thickened septa. The space occupied by the gizzard—the whole of the space formed by the cœlom of segments vii. and viii.—appears to be entirely undivided by any septum or even traces of that partition.

Vascular system.—The only point to which I direct attention in the structure of the vascular system is the number and the position of the "hearts." Of these there are six pairs, of which the first lie in the viiith and the last in the xiiith segment.

Nephridia.—These organs consist, as in the other species of the genus, of numerous micronephridia.

Reproductive organs.—The male gonads and their duct and the sperm-sacs are in this, as in other species of the genus, limited in number to a single pair. The *testes* and *funnels* lie in the xith segment, and the following one, whose capacity is thereby extended, contains the sperm-sacs. The *sperm-sacs* are of considerable size, measuring 6 mm. in extreme length; they are flattened and broad, and of a roughly triangular form, the apex of the triangle being posterior in position, the margins are somewhat lobulate. The *spermiducal glands* are each coiled into a tight mass, throughout which, however, the tubular structure of the gland is perfectly obvious. The muscular duct is of fair length, and its calibre is barely one third of that of the thicker parts of the gland-tube. Between the opening of the two glands the ganglionic swelling upon the nerve-cord is considerably larger than the corresponding swellings in other segments.

The penial setæ are rather longer than those of *T. incommodus*, of which a drawing is exhibited (text-fig. 57, p. 202), and they are remarkable for being apparently of a very delicate structure at the free end, which in all the setæ that I have examined was much bent and in different directions. The extremity is hardly sculptured, a very fine pitting being all that is visible.

The *spermathece* have a longish muscular duct, to the commencement of which upon the outside is affixed a somewhat fan-shaped diverticulum.

Typhoeus incommodus, n. sp.

Of this smaller species, which is from the same locality as the last, I have examined two individuals, one of which was larger than the other, both, however, being fully mature.

The length of the larger individual is 90 mm.; it has about 125 segments.

The first three segments are simple and without annuli. The next three segments are biannulate, and the rest in front of the clitellum have three annuli, upon the middle one of which are situated the setæ. After the clitellum up to nearly the end of the body the segments are also triannulate.

The *prostomium* is as in the last species. Its features are illustrated in the accompanying drawing (text-fig. 56). The couples of *setæ* are all of them farther apart, relatively speaking, than they are in the last species. But, as in *T. nicholsoni*, the two setæ of each ventral couple are nearer together than those of the lateral couples. The individual setæ of the lateral couples get rather farther away from each other towards the posterior end of the body.

The present species is also characterized by the number and position of the *genital papillæ*. There are four pairs of these in both specimens, which are found only upon the clitellar segments, the xiiith to the xvth inclusive. The papillæ are exactly on a line with the ventral couples of setæ, and their size is such that they occupy roughly the same amount of space upon the body. The papillæ lie close to the posterior border of their respective segments, but not actually on the border line as apparently they do in *T. orientalis*. The genital papillæ project somewhat from the general body surface and have a rim of white surrounding a darker central area. They are almost circular in outline.

The *male generative pores* lie upon the xviiith segment, their position being a little to the outside of the ventral couples of setæ. They are borne upon prominent rounded papillæ of circular contour marked off by grooves from the surrounding integument.

The *oviducal pores* are unquestionably paired in the present species. They lie in front of the innermost seta of each ventral couple.

The *spermathecal pores* are conspicuous slit-like orifices with crenated lips. They lie farther apart than in *T. nicholsoni*, between the ventral and lateral couples of setæ.

The *alimentary canal* offers two points of difference from that of the last species. There is a definite pair of calciferous glands in segment xii., and the intestinal glands are situated farther forward, beginning in the lxviiith segment. As in *T. nicholsoni*, the gizzard is large and lies mainly (? entirely) in segment viii.

There are two specially thickened *septa* in front of the gizzard and three behind it. The last of the latter separates segments x./xi.

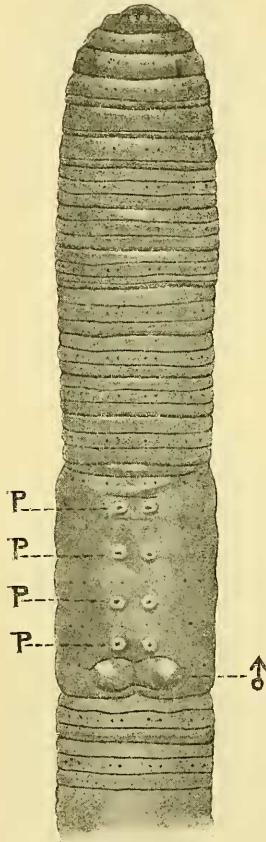
The last *heart* is in segment xiii.

The *nephridia* are numerous in each segment.

The *organs of reproduction* show one unexpected feature which has not hitherto been recorded in this genus and which serves to

bring it nearer to *Megascolides*. There are two pairs of sperm-sacs which occupy what Dr. Michaelsen regards as the primitive position, *i. e.*, segments ix. and xii. They are roughly triangular-shaped sacs, and are lobulate; the two pairs are very different in size, those of segment xii. being rather the larger. There are, however, but a single pair of funnels, which are larger and lie as usual in the xith segment.

Text-fig. 56.

*Typhoeus incommodus*. Head-end, $\times 4$.

♂, male pore; P, papillæ.

The coiled *spermiducal glands* present no remarkable features. The glandular part is a great deal thicker than the muscular duct. The latter is very short, much shorter than in the last species, and is only bent once on the right side and into a W on the left.

The *penial setæ* are illustrated by the accompanying drawing (text-fig. 57); the distal end of each seta is but faintly ornamented with a few transverse ridges.

Text-fig. 57.



Typhoeus incommodus, penial seta, greatly magnified.

The *spermathecae* are large globular sacs. The diverticula form a complete frill of small sacs round the duct of the spermatheca.

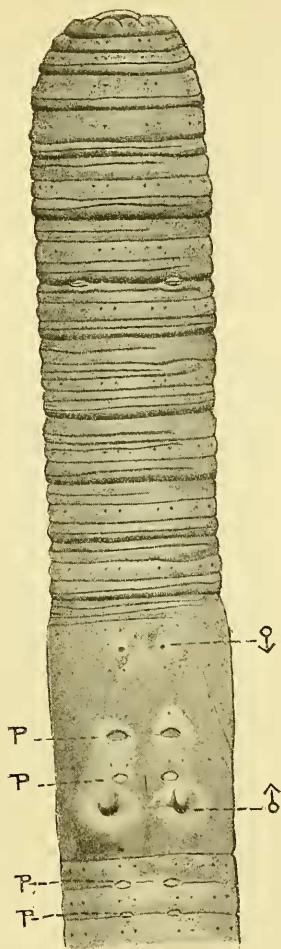
Typhoeus masoni Bourne.

Typhoeus masoni A. G. Bourne, J. A. S. B. lviii. p. 112.

Prof. Bourne examined and reported upon a single individual only of this species from Dehra Dun. I have acquired a second specimen, also fully mature, from the same locality and beg to offer a few notes thereon. My specimen measures 146 mm. in length. Beyond observing that the anterior segments are bi- to quadr-annulate, the description of the species gives no details of the annulation of these segments. As this matter appears to be of specific value, I give a detailed account of the annulation in elucidation of the accompanying woodcut (text-fig. 58). The first segment is simple; the second is fairly annulate, the third and fourth very decidedly so. In both of them the setæ are implanted upon the first of the two annuli. The fifth ring is primarily bi-annulate, but each annulus is again subdivided. The next segment is divided into three marked annuli, of which the middle one bears

the setæ; the first and the third annulus are fairly subdivided, so that the somite may be said to have 5 annuli. The seventh and eighth segments have the same subdivisions as the last. Eight

Text-fig. 58.



Typhoeus masoni. Head-end, $\times 4$.
 ♀, oviducal pores; ♂, male pores; P, papillæ.

annuli can be counted in the ixth segment, 6 in the xth, 5 in the next two, which brings us to the commencement of the clitellum.

The *genital papillæ* are, as figured by Bourne, four pairs. He does not mention, however, certain slight differences in the position of the different pairs. The first pair, *i. e.*, those lying between segments xv./xvi., and the last two pairs correspond in position to the outermost of the two ventral setæ; that is to say, a line drawn from this seta would pass through the middle of the papilla. On the other hand, the second pair lie between the two setæ of the ventral couple. As Bourne states, the two anterior pairs of papillæ are much more marked than the two posterior pairs.

I find the position of the *oviducal pores* rather different from that illustrated by Bourne. Each lies in front of the inner seta of the ventral couple; it is noteworthy, perhaps—in connection with the remarks that I have made above concerning the asymmetry of the oviducal pores of *T. nicholsoni*—that in the present species the left-hand pore is decidedly the larger.

The excellent condition of preservation of my specimen enables me to add a few details to our knowledge of the internal anatomy of this species.

I find that the arrangement of the septa is a little different from that described by Bourne. The first plainly recognizable septum, which is also fairly thick, separates segments v. and vi. Then follows a much stouter septum, which limits anteriorly segment vii., in which segment lie the spermatheca. Behind the spermatheca and attached to the anterior end of the gizzard is a thin and delicate septum. The gizzard therefore occupies segment viii. It is followed by three thickened septa, to the first of which it is attached by two symmetrically placed strap-shaped bands of muscle. The position of some of the organs of the body is a little difficult to ascertain, and appears to vary from what I have described above in *T. nicholsoni*.

I believe Bourne to be right in placing the anterior end of the sperm-sacs in segment xi.; they extend back to xiii. There is, however, no real anomaly inasmuch as these sacs are not attached to septum x./xi.; they may be considered to belong morphologically to segment xii., from which they have grown forwards as well as backwards. The calciferous glands I should place in segment xii. The last hearts are in xiii.

I find five pairs of intestinal glands—not four as Bourne has stated; they are bilobed, the furrow being transverse.

The several species of the genus *Typhoeus* show a very considerable uniformity of internal structure, combined with a marked variation in the numbers and the arrangement of the genital papillæ. Unfortunately data are wanting as to the internal structure of *Typhoeus laevis*, and several details of importance from a systematic point of view have been left undescribed by myself in *T. orientalis*, which, however, as the first known species of the genus was amply characterized as such. The only real difference in the internal structure which can be deduced from our present knowledge is the

fact that in *T. incommodus* there are the two pairs of sperm-sacs of many *Megascolex* and *Megascolides* in segments ix. and xii., which Dr. Michaelsen has thought to be the primitive arrangement of those sacs among earthworms. That species also combines with this divergence in structure a peculiar disposition of the spermathecal diverticula, which are not arranged in a pair of trifid or multifid appendages as in other species, but in a continuous circle of sacs round the spermatheca. We may perhaps regard this form as the starting point of the genus, the other conditions being arrived at by a loss of one pair of sperm-sacs and a reduction of the spermathecal appendages. It is to be remarked that in other species the sole remaining pair of sperm-sacs has increased in size, which may be connected perhaps with the disappearance of the anterior pair.

The following is a complete definition of the

Genus **TYPHOEUS** Beddard.

Small to moderate-sized earthworms, with 8 setæ per segment arranged in couples. Prostomium large. Clitellum occupying segments xiii.-xvii., partly or entirely. Male pores very conspicuous and upon segment xvii., corresponding in position to ventral setæ. Spermathecal pores upon the interval vii./viii. Genital papillæ one to six pairs upon clitellar and neighbouring segments; rarely absent (?). Dorsal pores present. Gizzard single in viii.; one pair of calciferous glands in xii. Intestine furnished with six pairs of glands beginning at about segment lxxx. Excretory organs micronephridia. Dorsal vessel single. A single pair of testes, funnels, sperm-ducts, and (except in *T. incommodus*) sperm-sacs. Spermiducal glands tubular, with penial setæ. Spermatheca one pair with one or two diverticula, or more.

Hab. India, Ceylon, Burmah.

The seven species may be thus briefly characterized:—

Typhoeus orientalis.

T. orientalis Beddard, Ann. Nat. Hist. (5) xii. p. 219.

Length about 100 mm. Genital papillæ between segments xiii./xvii. and xviii./xx. in line with ventral setæ. Spermathecal pores corresponding to ventral setæ. Spermatheca with two small and trifid diverticula. Penial setæ with chevron-shaped striæ at free end.

Hab. Neighbourhood of Calcutta.

Typhoeus gammii.

T. gammii Beddard, Quart. Journ. Micr. Sci. xxix. p. 111.

Length 250 mm. Genital papillæ single and elongated between xix./xx., xx./xxi. Setæ paired ventrally, farther apart in lateral

pairs. Spermathecal pores corresponding to interval between ventral and dorsal setæ. Spermathecæ with paired diverticula, which are multifid. Penial setæ with wavy ridges round distal end.
Hab. Darjiling.

Typhoeus masoni.

T. masoni Bourne, J. A. S. B. lviii. p. 112.

Length 146 mm. Genital papillæ paired between xv./xvii., xviii./xx., corresponding to ventral setæ. Setæ closer in ventral pairs; posteriorly lateral setæ get wider apart. Spermathecal pores correspond to interval between ventral and lateral setæ. Spermathecæ with two diverticula bifid or trifid. Penial setæ both smooth and with distal chevron-shaped striæ.

Hab. Dehra Dun.

Typhoeus lævis.

T. lævis Rosa, Ann. Mus. Civ. Genova, (2) ix. p. 388.

T. lævis Rosa, Ann. k. k. Hofmus. Wien, vi. p. 388.

Length 35 mm. Papillæ paired upon xvii. and xviii. Setæ of lateral pairs farther apart than those of ventral.

Hab. Burmah and Ceylon.

Typhoeus foveatus.

T. foveatus Rosa, Ann. Mus. Civ. Genova, (2) ix. p. 382.

Length 180 mm. No genital papillæ (?). Setæ of lateral pair farther apart than those of ventral. Spermathecal pores corresponding to ventral setæ. Spermathecæ with two simple diverticula. Penial setæ with minute points at end.

Hab. Rangoon.

Typhoeus nicholsoni, n. sp.

Length 135 mm. Genital papillæ one pair on xvi. Setæ of ventral pair closer than those of lateral; the latter a trifle wider apart posteriorly. Spermathecal pores correspond to ventral setæ. Spermathecæ with paired diverticula which are trifid. Penial setæ with very faint ornamentation.

Hab. Neighbourhood of Calcutta.

Typhoeus incommodus, n. sp.

Length 93 mm. Papillæ paired upon xiii.–xvi. behind ventral setæ. Setæ of lateral pairs farther apart than those of ventral, posteriorly considerably farther apart. Spermathecal pores between pairs of setæ. Spermathecæ with a ring of many diverticula. Two pairs of sperm-sacs in ix. and xii. Penial setæ with a few faint ridges.

Hab. Neighbourhood of Calcutta.